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MYCELIUM BIO-COMPOSITES: THE FUTURE OF PACKAGING MATERIALS

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Abstract: *Fungi have been used for centuries for a variety of purposes, including as a source of food, medicine, and industrial products. In recent years, there has been growing interest in using fungi strains to obtain novel biomaterials with unique properties that can be used in various applications, including in the field of biotechnology. One example of a fungi strain used for obtaining novel biomaterials is Ganoderma lucidum, also known as the reishi mushroom. This strain has been shown to produce polysaccharides with antioxidant and anti-inflammatory properties, which have potential applications in the development of nutraceuticals and pharmaceuticals. Aspergillus oryzae strain is widely used in the production of a traditional Japanese seasoning called koji. Koji is used to break down starches and proteins in foods, and it has been found to have a variety of potential health benefits, including improving digestion and boosting the immune system. Fungal mycelium of the mushroom species Schizophyllum commune, which has been used to create a biodegradable packaging material that has properties similar to polystyrene foam. This material is sustainable, compostable, and can be produced using waste products, making it an eco-friendly alternative to traditional packaging materials. Overall, the use of fungi strains for obtaining novel biomaterials has great potential for the development of new and sustainable materials with unique properties. As research in this area continues to expand, it is likely that we will see even more exciting applications for these versatile organisms.*

Key words: *fungi strains, biomaterials, novel materials, packaging, composites*

1. INTRODUCTION

Mycelium-based biomaterials are materials that are made from the root structure of mushrooms, which is called mycelium. Mycelium is a natural and renewable resource that can be grown into a range of shapes and structures, making it a versatile biomaterial. Mycocomposites are a type of biomaterial that are made from a combination of mycelium (the root-like structure of fungi) and a natural fibrous substrate such as agricultural waste or wood chips [1]. Mycelium grows by breaking down organic matter, and when it is combined with the substrate in a controlled environment, it forms a strong, lightweight, and durable material that can be used in a variety of applications. To create mycelium-based biomaterials, mycelium is grown in a controlled environment, where it forms a network of tiny threads called hyphae. These hyphae can be mixed with various organic materials such as agricultural waste, sawdust, or straw, to create a composite material that can be molded into a desired shape. The resulting material is then dried and processed to create a durable and biodegradable product. Mycelium-based biomaterials have a number of

potential applications, including packaging materials, building materials, and textiles. They are biodegradable, compostable, and have a low environmental impact compared to traditional petroleum-based materials. They are also lightweight, strong, and insulating, making them a promising alternative to traditional materials in a wide range of industries [2].

2. CONTEXT

Mycelium packaging (Fig. 1) is a sustainable and eco-friendly alternative to traditional packaging materials such as plastic or Styrofoam. It is made from mycelium, the root structure of mushrooms, which is a natural and renewable resource that can be grown into a range of shapes and structures. Packaging waste is a growing environmental problem around the world. According to the United Nations Environment Programme, up to 85% of all plastic packaging is discarded and not recycled. This has led to a buildup of plastic waste in landfills and in the environment, with devastating consequences for wildlife and ecosystems. The need for alternative solutions to packaging waste has never been more pressing [3]. Governments and companies are looking for sustainable and eco-friendly alternatives to traditional packaging materials such as plastic, which are causing significant harm to the environment.

Fig. 1: Mycelium derived packaging materials
(Source: www.weforum.org; www.naturamushrooms.com)

Biomaterials, including mycelium packaging, offer a promising solution to this problem. They are made from natural and renewable resources, and are biodegradable and compostable. Unlike traditional petroleum-based materials, biomaterials do not release harmful chemicals into the environment when they break down, and they do not contribute to the buildup of plastic waste in landfills [4]. The use of biomaterials in packaging is gaining traction among companies and consumers alike. Major corporations such as Dell, IKEA, and Ecovative Design are already using mycelium packaging, and others are exploring the use of other various biomaterials.

However, the adoption of biomaterials as a replacement for traditional packaging materials faces some challenges. For example, biomaterials are still relatively new and not yet widely available or cost-effective. They also require specific conditions for production, such as controlled environments and specific materials for growth. Despite these challenges, the potential benefits of biomaterials in reducing packaging waste make them a promising solution for a more sustainable future. As research and development continue, the adoption of biomaterials in packaging is expected to grow, leading to a more environmentally friendly and sustainable packaging industry [5].

3. CURRENT PRODUCTS

Companies such as MycoWorks (Fig. 2) and Ecovative Design (Fig. 3) have developed mycelium-based products such as furniture, packaging, and building materials. MycoWorks is a California-based biotechnology company that specializes in developing sustainable biomaterials using mycelium, the vegetative part of the fungus. Ecovative Design is a New York-based biomaterials company that specializes in developing sustainable alternatives to plastic foam and other petroleum-based materials. The company also produces other mycelium-based products such as MycoBoard, a sustainable alternative to particleboard, and MycoFlex, a flexible material that can be used in footwear and other applications. These types of materials have the potential to make a significant impact on reducing plastic waste and promoting a more sustainable future.

Fig. 2: MycoWorks products obtained from fungal mycelium
(Source: www.mycoworks.com)

Fig. 3: Ecovative Design products: shoebox cooler and mycelium chair
(Source: www.ecovative.com, www.forager.bio)

Other examples include several companies that are all working towards developing sustainable alternatives to traditional materials using mycelium, which has the potential to revolutionize various industries and reduce the environmental impact of our consumption habits:

Bolt Threads - a California-based company that uses mycelium to produce a sustainable alternative to leather called Mylo (Fig. 4); Mogu - an Italian company that produces mycelium-based materials for use in furniture, interior design, and other applications (Fig. 5); Biohm - an UK-based company that uses mycelium to produce sustainable building materials such as insulation, panels, and bricks (Fig. 6); Mycelium Solutions - a Netherlands-based company that produces mycelium-based packaging materials (Fig. 7); Grown.bio - a Spanish company that produces mycelium-based leather alternatives and other sustainable biomaterials (Fig. 8).

Fig. 4: Bolt Threads' Mylo material and Stan Smith Mylo™ adidas
(Source: www.boltthreads.com)

Fig. 5: Mogu's acoustic panels made from fungal myceliyum
(Source: www.mogu.bio)

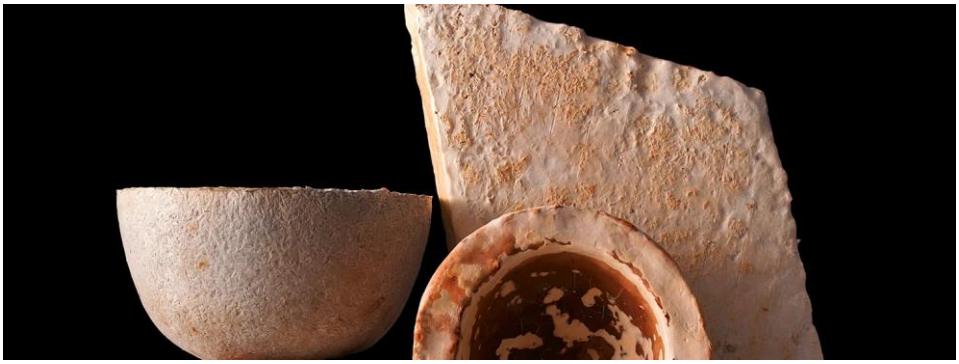

Fig. 6: Mycelium insulation material
(Source: www.biohm.co.uk)

Fig. 7: Mycelium obtained foam materials and composites
(Source: www.myceliummaterials.nl)

Fig. 8: GROWN bio mycelium packaging materials
(Source: www.grown.bio)

The future of packaging materials is increasingly being shaped by concerns over sustainability and reducing carbon dioxide footprint. With the world becoming more aware of the impact of plastics and other traditional packaging materials on the environment, companies are looking for alternative biomaterials that can replace them [6]. One of the main drivers of this shift is the need to reduce the carbon dioxide footprint of packaging. Packaging materials contribute significantly to greenhouse gas emissions, and companies are now looking for ways to reduce this impact [7]. One solution is to use biodegradable materials that can break down naturally, without releasing harmful chemicals into the environment. In conclusion, the future of packaging materials is likely to be shaped by the need to reduce carbon dioxide footprint and increase sustainability. Biomaterials offer a promising alternative to traditional packaging materials, offering a range of benefits including lower carbon footprint, biodegradability, and recyclability. As companies continue to invest in research and development of these materials, we can expect to see a shift towards more sustainable and environmentally friendly packaging solutions in the future [8].

Mycelium composites offer several advantages over traditional packaging materials, including a lower carbon footprint, biodegradability, and compostability. They are also lightweight, strong, and flexible, making them an ideal choice for a wide range of applications. In addition to their sustainability credentials, mycelium composites are also highly versatile. They can be molded into a wide range of shapes and sizes, making them ideal for packaging a wide range of products. They can also be coated with natural materials, such as wax or oil, to improve their water resistance and durability.

In conclusion, mycelium composites are a highly promising source of alternative packaging materials that offer a range of benefits over traditional materials. As research and development continue in this area, we can expect to see an increasing number of companies exploring the use of mycelium composites in their products. With their sustainability credentials, versatility, and low environmental impact, mycelium composites are likely to play an important role in the future of sustainable packaging materials.

4. CONCLUSIONS

Mycocomposites have several advantages over traditional materials such as plastic or wood. They are biodegradable, sustainable, and can be produced using low energy inputs. Additionally, mycocomposites have excellent insulation properties, and they can be molded into various shapes and sizes. They are also fire-resistant and can be engineered to have specific properties such as water resistance, strength, or flexibility. Mycocomposites are being explored as a potential alternative to traditional materials in a range of industries, including packaging, construction, and furniture production. They offer a promising solution to some of the environmental challenges we face today, and they have the potential to be a sustainable and eco-friendly material of the future.

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